LATTICE AND METHOD AND APPARATUS FOR PRODUCING LATTICE

Field of the Invention

This invention relates to lattice, a lattice pin, and method and apparatus for producing lattice. The invention has particular application to lattice which is formed from lattice box sections which are made from metal such as aluminium.

Background Art

Lattice formed from aluminium box section generally comprises a plurality of lattice sections which extend in a first direction and a plurality of lattice sections which extend in a direction transverse to the first direction. Most typically, the lattice sections extend horizontally and vertically with respect to one another or at 45° to the vertical with respect to one another. The lattice sections are joined together by fasteners which most preferably enable the sections to pivot relative to one another, so that the lattice can be folded into a storage or closed configuration or extended into a deployed or open configuration.

One conventional form of connecting the lattice sections together, is to drill holes in the lattice sections and join them by pop rivets or like fasteners. In more recent times, specially designed plastic fasteners have been employed which are inserted into the drilled holes in the lattice sections. The fasteners include lugs which project outwardly of a generally cylindrical body, and which, upon insertion into a hole, deflect inwardly so that the lugs can pass through the hole, and then once passed through the hole, bias outwardly under their own resiliency so that a part of the lug can engage on an inner surface of the lattice section to thereby join the fastener to the lattice section, and therefore join two lattice sections together.

The use of pop rivets and like fasteners, and also the plastic lugs described above, both require the lattice sections to be pre-drilled to provide holes in which the fasteners can be located. The use of plastic lugs of the type described above does enable the lattice to be folded, but the lattice is generally not self-supporting. Furthermore, the assembled structure tends to have considerable flexural movement. Simply, the sections bend and the forces are magnified, causing individual sections to pop off the assembly, making them unsatisfactory for handling purposes. Furthermore, when the pre-drilled holes are formed, burrs are created during the drilling operation and restoring of the sections which have separated, as well as the folding of the assembly, degrades or damages the plastic pins, thereby resulting in the pins not securely holding the lattice sections together, further facilitating the possibility of separation of the lattice sections.

Summary of the Invention

The object of the present invention is to provide a lattice pin, a lattice, and also apparatus and method for forming lattice, which produces a much more secure connection of the lattice sections so that the sections do not tend to separate during transport, or when the lattice is being installed in a structure.

A first aspect of the invention may be said to reside in a lattice pin for joining lattice sections to form a lattice, said pin including:

a mid-section having a first shoulder for abutting an outer surface of a first lattice section, and a second shoulder for abutting an outer surface of a second lattice section to which the said first lattice section is to be joined;

a first pin section extending outwardly from the

mid-section, and including a taper which defines a burst end for bursting through the lattice section;

a second pin section extending outwardly from the mid-section in a direction opposite the first pin section, and having a taper for defining a second burst end for bursting through the second lattice section; and

wherein the bursting of the pin sections through the lattice sections couples the lattice pin to the sections and therefore, in turn, couples the lattice sections together, with the first and second shoulders abutting the lattice sections respectively to separate the lattice sections and allow movement of the lattice sections with respect to one another.

It has been found that by providing a pin which bursts through the lattice sections, a very strong joining of the lattice sections can be provided which resists separation of the lattice sections by pulling the lattice sections apart. Thus, a very strong and sturdy lattice can be formed, whilst still providing the ability of the lattice to be folded from a closed position and then extended to an open configuration.

Preferably each taper includes a first tapered portion having a first taper, and a second tapered portion arranged between the first taper and the respective shoulder of the mid-section, the second tapered portion having a second taper which is more gradual than the first taper.

Preferably the second tapered portion includes serrations for facilitating gripping of the second tapered portion to the lattice when the pin sections burst through the lattice sections.

Preferably the mid-section is cylindrical and the shoulders are formed by end surfaces of the cylindrical

mid-section, arranged diametrically outwardly of the pin sections.

A second aspect of the invention may be said to reside in a lattice including:

a plurality of lattice sections extending in a first direction;

a plurality of overlapping lattice sections extending in a direction transverse to the first direction; and

a plurality of lattice pins, as described above, interconnecting the lattice sections at locations where the lattice sections overlap one another.

In one embodiment, the first lattice sections are arranged substantially vertically having regard to the orientation in which the lattice is to be installed, and the second lattice sections are arranged substantially horizontally.

In another embodiment, the first lattice sections are arranged at an angle of about 45° to the horizontal, having regard to the orientation in which the lattice is to be installed, and the second lattice sections are arranged perpendicular to the first lattice sections.

A further aspect of the invention may be said to reside in a lattice forming machine including:

indexing means for indexing the lattice section relative to a pin insertion station;

lattice pin feeding means for feeding lattice pins to the pin insertion station; and

pin insertion means at the station for sequentially engaging said pins so that, when the lattice section is indexed by the indexing means relative to the station, the pin insertion means forces the pins into the lattice section so that the pins burst through the lattice section to thereby provide a lattice section, from which a

lattice can be formed, in which a plurality of lattice pins are inserted.

Preferably the indexing means comprises an indexing cylinder and extendible and retractable ram arm, clamping means on the ram arm for clamping the lattice section, so that when the ram arm is extended, the lattice section is moved with the ram arm, and when the clamp is released, the ram arm and clamp can be retracted relative to the lattice section to then again clamp the lattice section and index the lattice section upon repeated extension of the ram arm.

Preferably the clamp comprises a clamp housing through which the lattice section passes, a clamp cylinder and clamp ram arm carried on the ram arm of the indexing cylinder, and whereupon extension of the clamp cylinder ram arm causes the lattice to be clamped between the clamp cylinder ram arm and a portion of the housing so that upon extension of the indexing cylinder ram arm, the lattice section is carried with the clamp housing to thereby index the lattice section.

Preferably the pin feeding means comprises:

a drum for containing a plurality of pins;

a guide chute having one end located in the drum for receiving pins for guiding movement of the pins to a second end of the chute;

a moveable feeder for receiving pins from the chute and for moving the pins to the insertion station; and

a press head for engaging the pins at the insertion station and for forcing the pins into the lattice section.

Preferably the press head is carried by a ram arm of a pneumatic press cylinder, so that upon extension of the

ram arm, the press head engages the pin and presses the pin into the lattice section so that the pin bursts through the lattice section.

Preferably the feeder comprises a rotary feed plate having a plurality of recesses for receiving pins from the chute and orienting the pins for insertion into the lattice section.

Preferably the apparatus includes feeder moving means for moving the feeder relative to the pin so as to disengage the pin from the feeder after engagement by the press so that the pin can be pressed into the lattice section without interference from the feeder.

Preferably the feeder plate includes a plurality of recesses, each for receiving a pin, and indexing means for indexing the feeder plate so as to present pins at the insertion station for engagement by the press upon each indexing of the lattice section relative to the insertion station.

Preferably the feeder plate indexing means comprises an indexing plate coupled for rotation with the feeder plate, the indexing plate having a plurality of ratchet portions, and a pawl mechanism for engaging the ratchet portions and causing rotation of the ratchet plate to thereby index the ratchet plate and the feeder plate to bring the pins held by the feeder plate sequentially to the insertion station.

Preferably the pawl comprises an indexing cylinder and ram arm for engaging the ratchets of the ratchet plate, and biasing means for biasing the ram arm into engagement with the ratchet plate.

A further aspect of the invention may be said to reside in a feeding apparatus for feeding a work piece to a work

station, including:

support means for supporting a plurality of said articles, one above another;

moving means for moving a lowermost one of the articles out of the stack of articles; and

feeding means for feeding the moved article to a work station.

Preferably the support means comprises a support structure inclined with respect to the vertical, so the stacked articles can rest in a stacked configuration against the support member.

Preferably the moving means comprises:

at least one pivotally mounted abutment member; and

a ram coupled to the abutment member for pivoting the abutment member from a retracted position to an extended position so that during movement of the abutment member between the retracted position and extended position, the abutment member engages the lowermost article and pushes the article sideways with respect to the stack of articles.

Preferably the feeding means comprises a ram for pushing the article in a direction transverse to the sideways movement of the article.

A further aspect of the invention may be said to reside in an unloading rack for receiving elongate work pieces, including:

a support member for receiving one of the elongate members;

an inclined guide section extending from the support section;

a stop at a lower portion of the inclined guide section; and

driving means for moving the elongate member off the support section and on to the inclined section so that the work piece slides down the inclined section towards the stop.

Preferably the drive means comprises at least one ejection nozzle for ejection of air to blow the work piece off the support section and on to the inclined section.

A still further aspect of the invention may be said to reside in an apparatus for assembling a lattice, including:

a support section for supporting a plurality of first lattice sections which extend in a first direction and a plurality of overlapping second lattice sections which extend in a direction transverse to the first direction, the first lattice sections each having a plurality of pins, each pin having a first pin section penetrating one of the first lattice sections, and a second pin section adjacent one of the second lattice sections; and

a roller assembly having a plurality of roller pairs, each roller pair having two rollers separated by a different distance which decreases from a feed end to an exit end of the roller assembly, for receiving the first plurality and second plurality of lattice sections, and for pressing the lattice sections together so as to cause the second pin sections to penetrate into the second plurality of lattice sections to thereby couple the first and second lattice sections together to form the lattice.

Preferably the plurality of roller pairs comprise a first roller pair at the feed end of the roller assembly, a second roller pair at the exit end of the roller assembly, and at least one intermediate roller pair between the first and second roller pairs, the distance between the rollers in each roller pair decreasing from the first

roller pair at the feed end to the second roller pair at the exit end of the roller assembly.

Preferably each roller pair comprises a first upper roller and a second lower roller, drive means for driving one of the rollers in each roller pair so as to draw the lattice sections through the roller assembly so the lattice sections are pressed together to cause the second pin sections to penetrate the second lattice sections.

Preferably the drive means comprises a motor and drive belt arrangement.

Preferably an upper roller in each roller pair is coupled to position adjusting means for adjusting the position of the upper roller relative to the lower roller in each roller pair, to thereby set the distance between the rollers in each roller pair.

The invention may also be said to reside in apparatus for forming a lattice from a plurality of first lattice sections, a plurality of second lattice sections, and pins having a first pin portion and a second pin portion which extends in a direction opposite the first pin portion including:

pin inserting means for inserting the pins into each of the first lattice sections so that the first pin portions burst through the lattice section and penetrate into the lattice section;

a support platform for supporting a plurality of the said first lattice sections with the pins, and a plurality of overlapping said second lattice sections extending in a direction transverse to the first lattice sections and being adjacent the second pin portions of the pins; and

a roller assembly having at least one pair of rollers for concurrently receiving the first lattice

sections and the second lattice sections and pressing the second lattice sections towards the first lattice sections so the second pin portions penetrate the second lattice sections to thereby couple the first lattice sections to the second lattice sections.

Preferably the roller assembly includes a plurality of roller pairs, the plurality of roller pairs including a first entry roller pair and a second exit roller pair, the distance between the two rollers forming each roller pair decreasing from the first roller pair to the second roller pair, so as to progressively press the plurality of first lattice sections towards the plurality of second lattice sections, so that the second pin portion progressively penetrates into the second lattice sections to thereby couple the second lattice sections to the first lattice sections.

Preferably at least two intermediate roller pairs are arranged between the first roller pair and the second roller pair.

Preferably the support platform includes a plurality of support guides for supporting the first lattice sections in a folded configuration and for supporting the second lattice sections also in a folded configuration, so that when the first and second lattice pairs are concurrently fed through the roller assembly, the lattice is formed in a folded configuration and, after exit from the roller assembly, can be opened into a deployed configuration.

Preferably the support platform comprises a jig having a lower platen, the support guides comprising locater pins extending upwardly from the lower platen, so that the first lattice sections and second lattice sections can be located between sets of the locater pins in the folded configuration, a top platen having a plurality of bores

for registering with the locater pins and for enabling the top platen to move downwardly towards the lower platen when the jig moves through the roller assembly, whereby pressed the first lattice sections and second lattice sections together.

Preferably the apparatus further includes a cutting station for cutting the first and/or second lattice sections to a predetermined length to suit the size of the lattice to be produced by the apparatus.

Preferably the apparatus includes a feeding mechanism having support means for supporting a plurality of first lattice sections in a stack one above another, moving means for moving a lowermost one of the first lattice sections out of the stack of lattice sections, and feeding means for feeding the moved section to the pin insertion means.

Preferably the support means comprises a support structure inclined with respect to the vertical, so the stacked articles can rest in a stacked configuration against the support member.

Preferably the moving means comprises:

at least one pivotally mounted abutment member; and

a ram coupled to the abutment member for pivoting the abutment member from a retracted position to an extended position so that during movement of the abutment member between the retracted position and extended position, the abutment member engages the lowermost article and pushes the article sideways with respect to the stack of articles.

Preferably the apparatus also includes an unloading table for receiving first lattice sections having pins from the

pin inserting means, the loading table having a support member for receiving one of the elongate members, an inclined guide section extending from the support section, a stop at a lower portion of the inclined guide section, and driving means for moving the elongate member off the support section and onto the inclined section so that the lattice section slides down the inclined section towards the stop.

Preferably the drive means comprises at least one ejection nozzle for ejection of air to blow the lattice section off the support section and onto the inclined section.
The invention may also be said to reside in apparatus for forming a lattice, including:

a roller assembly having a plurality of roller pairs which comprise an entry roller pair, an exit roller pair, and at least one intermediate roller pair, the rollers in each roller pair being separated by a distance which gradually decreases from the entry roller pair to the exit roller pair, so that when a lattice assembly formed of a plurality of first lattice sections, and a plurality of second lattice sections overlapping the first lattice sections, and pins between the first and second lattice sections, is passed through the roller assembly, the first lattice sections are progressively pressed towards the second lattice sections as the lattice assembly passes through each roller pair, so as to progressively cause the pins the penetrate into at least the second lattice sections to therefore join the lattice sections together and form the lattice.

Preferably the first lattice sections are provided with the pins which penetrate and embed into the first lattice sections prior to delivery of the lattice assembly to the roller assembly, so that when the first and second lattice sections are progressively pressed together, the pin then penetrates into the second lattice sections to join the

first and second lattice sections together.

The invention may also be said to reside in a method of forming a lattice section from which a lattice is to be made, including the steps of:

indexing the lattice section relative to a pin insertion station;

feeding the pins to the pin insertion station; and

forcing the pins into the lattice section along the length of the lattice section so that the pins burst through the lattice section and embed in the lattice section.

The invention may also be said to reside in a method of manufacturing a lattice including the steps of:

supporting a plurality of first lattice sections and a plurality of second lattice sections in overlapping configuration, the first lattice sections being provided with embedded pins, and each pin having a pin portion extending out of the lattice in which the pin is embedded and being arranged adjacent the second lattice sections;

concurrently passing the assembled first and second lattice sections through a roller assembly having a plurality of roller pairs, with the rollers in each roller pair being separated by a distance which decreases from a feed end of the roller assembly to an exit end of the roller assembly, so that the first and second lattice sections are pressed together as the lattice sections pass through the roller assembly, to cause the pin portions to penetrate the second lattice sections by bursting through the second lattice sections to thereby couple the first and second lattice sections together and form the lattice.

The invention may also be said to reside in a method for forming a lattice from a plurality of first lattice sections, a plurality of second lattice sections and pins

having a first pin portion, and a second pin portion which extends in a direction opposite the first pin portion, including the steps of:

indexing the first lattice sections past a pin insertion station and, at the pin insertion station, pressing a plurality of pins into each first lattice section so that the first pin portion bursts through the first lattice section and embeds in the first lattice section;

assembling the lattice by arranging the first lattice sections and second lattice sections in overlapping configuration, with the second lattice sections being adjacent the second pin portions; and

concurrently feeding the first and second lattice sections through a pressing station so that the first lattice sections are pressed towards the second lattice sections so that the second pin portions burst through and embed in the second lattice sections to thereby join the first and second lattice sections together to form the lattice.

Preferably the step of pressing the first and second lattice sections comprises the step of passing the assembled lattice sections through a roller assembly, having a plurality of rollers so that the first and second lattice sections are progressively pressed towards one another so that the second pin portions progressively penetrate into the second lattice portions.

The invention may also be said to reside in a method of forming a lattice from a lattice assembly which comprises a plurality of first lattice sections, a plurality of second lattice sections which overlap the first lattice sections, and pins disposed between the first and second lattice sections, said method comprising progressively pressing the first lattice sections towards the second lattice sections so that the pins progressively burst

through and embed in the second lattice sections to join the first and lattice sections together.

Preferably the method comprises pressing the lattice sections together by passing the lattice assembly through a plurality of roller pairs, in which the rollers of each roller pair are separated by a distance which decreases from an entry roller pair to an exit roller pair.

Preferably the method also includes, prior to passing the lattice assembly through the press, embedding the pins into the first lattice sections to that the pins embed in those lattice sections and extend out of the lattice sections for embedding in the second lattice sections upon pressing of the lattice sections together.

The invention may also be said to reside in a jig for supporting a lattice assembly for passing through a roller assembly to form a lattice from the lattice assembly, the jig including:

a lower platen having a plurality of upstanding locater pins, the locater pins defining channels in which a plurality of first lattice sections and a plurality of second lattice sections can be located in overlapping configuration, one of the first or second plurality of lattice sections having inbedded pins which project out of the lattice section, and the other of the lattice sections being arranged adjacent the inbedded pins;

a top platen having a plurality of bores which register with the locater pins so that the top platen can be located on the locater pins for sandwiching the first and second lattice sections between the top platen and the bottom platen; and

wherein when pressure is applied to the top platen, the top platen is pushed towards the bottom platen to, in turn push the first and second plurality of lattice sections together so that the inbedded pin penetrates the

other of the first or second lattice sections to thereby secure the first and second lattice sections together to form the lattice.

Brief Description of the Drawings

A preferred embodiment of the invention will be described, by way of example, with reference to the accompanying drawings in which:

Figure 1 is a view of a lattice according to one embodiment of the invention;

Figure 2 is a view of a lattice according to a second embodiment of the invention;

Figure 3 is a cross-sectional view through one pair of first and second lattice sections according to the preferred embodiment of the invention;

Figure 4 is an end view of a pin used in the preferred embodiments of the invention;

Figure 5 is a side view of the pin of Figure 4;

Figure 6 is a top view of a lattice section loading apparatus according to the preferred embodiment of the invention;

Figure 7 is a side view of the apparatus of Figure 6;

Figure 8 is an end view of the apparatus of Figure 6;

Figure 9 is a side view of a pin inserting apparatus according to the preferred embodiment of the invention;

Figure 10 is a detailed view of part of the apparatus of Figure 9;

Figure 11 is a detailed view of a different part of the apparatus of Figure 9;

Figure 12 is a cross-sectional view through a drum used in the preferred embodiment shown in Figure 9;

Figure 13 is a more detailed side view of the drum and associated parts of the apparatus of Figure 9;

Figure 14 is a plan view of a feed plate

according to the preferred embodiment of the invention;

Figure 15 is a more detailed side view of part of a press assembly according to the preferred embodiment of the invention;

Figure 16 is a view along the line I-I of Figure 15;

Figure 17 is a view of part of the embodiment shown in Figure 15;

Figure 18 is a plan view of part of the embodiment shown in Figure 15;

Figure 19 is a side view of an unloading rack according to the preferred embodiment of the invention;

Figure 20 is an end view of the rack of Figure 19;

Figure 21 is a detailed view of the circled part A of Figure 19;

Figure 22 is a detailed view of part of the apparatus of Figure 20 circled and marked B in Figure 20;

Figure 23 is a more detailed view of part of the apparatus of Figure 20 circled and labelled C in Figure 20;

Figure 24 is a side view of a cropping guillotine according to the preferred embodiment of the invention;

Figure 25 is an end view of the guillotine of Figure 24;

Figure 26 is a plan view of a roller assembly according to the preferred embodiment of the invention;

Figure 27 is a side view of the assembly of Figure 26;

Figure 28 is an end view of the assembly of Figure 26;

Figure 29 is a plan view of a jig used in the preferred embodiment of the invention;

Figure 30 is a cross-sectional view of the jig; and

Figure 31 is a view of a preferred modification to the jig shown in Figure 30.

Detailed Description of the Preferred Embodiment

With reference to Figure 1, a lattice according to a first embodiment is shown. The lattice includes a plurality of horizontally arranged lattice sections 12 and a plurality of vertically arranged lattice sections 14. This configuration is generally referred to as a 90° lattice in which the lattice sections are arranged horizontally and vertically having regard to the orientation in which the lattice is to be installed in a structure.

Figure 2 shows a second embodiment in which the lattice sections 12 are arranged at a 45° angle to the vertical and the lattice sections 14 are perpendicular to the sections 12, and therefore also arranged at an angle of 45° (taken from the opposition direction) to the vertical. This configuration is generally referred to as a 45° lattice.

The configuration shown in Figures 1 and 2 are well known and are typical lattice configurations used in many applications.

As is apparent from Figures 1 and 2, and is well known, the first lattice sections 12 overlap the second lattice sections 14 and, at the locations where the lattice sections 12 and 14 overlap, a fastener is located so as to secure the first and second lattice sections together to form the lattice.

As is shown in Figure 3, which shows one of the lattice sections 12 overlapping one of the lattice sections 14, the lattice sections 12 and 14 are coupled together by a pin 20.

The pin 20 is shown in more detail in Figures 4 and 5 and comprises a mid-section 22 which is generally cylindrical in configuration, and has a first end 24 and a second end

26. A first pin section 28 extends from the end 24 and a second pin section 30 extends from the end 26. Each pin section 28 is a mirror image of the other pin section 30 and therefore only the pin section 28 will be described in further detail. The pin section 28 comprises a first taper 32 which terminates in a burst end 34. The first taper 32 merges into a second taper 36 which is of a more gradual taper than the taper 32, as is clearly seen in Figure 5. The second taper 36 is provided with a plurality of ribs or serrations 38. The parts of the ends 24 and 26 which are arranged diametrically outwardly of the pin portions 28 and 30, form shoulders which abut outer surfaces of the lattice sections 12 and 14 when the pin joins two lattice sections together, as is shown in Figure 3.

As is apparent from Figure 3, the mid portion 22 also serves to separate the lattice sections 12 and 14 one from the other. The pin sections 28 and 30 are generally circular in cross-section and the lattice sections 12 and 14 are able to pivot on the pin sections 28 and 30 relative to one another, whilst being separated by the mid section 22 so that the lattice can be folded into a collapsed or closed position in which the first plurality of lattice sections 12 abut one another and the lattice sections 14 abut one another, to an open or deployed configuration, which is the configuration shown in Figures 1 and 2, and which is the configuration the lattice will have when it is installed in a framework or structure.

As will be described in more detail hereinafter, the pin 20 is applied to the lattice sections 12 and 14 so that the first pin section 28 bursts through the lattice section 12, and so that the serrations 38 engage the wall 12a of the lattice section 12 and the serrations on the pin section 30 engage the wall 14a of the lattice section 14. By causing the pin sections 28 and 30 to burst

through and penetrate into the lattice sections 12 and 14, an extremely tight and secure coupling of the pin to both the sections 12 and 14 can take place, whilst still allowing the sections 12 and 14 to pivot relative to one another on the pin sections 28 and 30 so the lattice can be moved from the folded position to the deployed or open position shown in Figures 1 and 2. It has been found that this technique of causing the pin sections 12 and 28 to burst through and penetrate the lattice sections 12 and 14, very firmly resists pulling apart of the lattice sections 12 and 14, which resistance is also facilitated by the serrations 38 engaging the walls 12a and 14a after the pin sections 28 and 30 penetrate through those wall sections 12a and 14a.

It is pointed out that the pin shown in Figures 4 and 5 is much larger than actual size. In the preferred embodiment of the invention, the mid-section 22 has a length of 3.5mm, the second tapered sections a length of 3mm, the first tapered section a length of 1.75mm, with the serrations extending for a length of approximately 2mm on the second tapered sections 36. Typically, the taper of the second taper 38 in the vicinity of the serrations 38 is 0.05:1mm. The taper of the first portion 32 is not particularly critical provided that the taper is sharp enough to present a burst end 34 which facilitates penetration of the pin sections 28 and 30 through the walls 12a and 14a of the lattice sections 12 and 14.

Figures 6 to 8 show a lattice loading apparatus according to the preferred embodiment of the invention. The apparatus includes a support platform 30 which comprises a plurality of cross members 32 and a main rail 34. A slightly inclined upstanding support frame 36 extends upwardly from the support 30 and comprises uprights 38. A top rail 40 is provided to join the upper ends of the uprights 38. The inclined support 36 and platform 30 are

supported on legs 42.

A plurality of fingers 44 are pivotally mounted on blocks 46 by pivot pins 43. The blocks 46 are connected to the rail 34. Each of the fingers 46 is connected to a rod 48 by pivot pin 49, and the rod 48 is coupled to a ram 50 of a cylinder 60. When the ram 50 is extended, the rod 48 is pushed to the right in Figure 6 to thereby pivot the fingers 44 around the pivot points in the direction of arrow A in Figure 6.

A plurality of lattice sections (not shown in Figures 6 to 8) are stacked one above the other on the rail 34 and cross members 32 and rest against the inclined support frame 36.

When it is desired to feed one of the lattice sections, the ram 50 is actuated to push the rod 48 to the left in Figure 6 so as to pivot the fingers 44 in the direction of arrow A so that the fingers 44 abut the lowermost section in the stack of sections and push the section towards the bottom of the page in Figure 6 in the direction of arrow B, or out of the plane of the paper in Figure 7. When the section has been pushed out of the stack in this manner, the fingers 44 are returned to their inactive position by retracting the ram 50 and rod 48 so that the stack moves down onto the rail 34 and cross members 32 ready for the next section to be moved laterally out of the stack in the same manner.

At one end of the rail 34, a feed cylinder 62 is provided. The feed cylinder 62 and the stack (not shown) are arranged so that an end of each of the sections in the stack will be just forward of, or almost abutting, the ram 63 of the cylinder 62 when the bottommost section is moved out of the stack in the above-mentioned manner. In order to feed the section which has been moved out of the stack,

the cylinder 62 is activated so that the ram 63 is extended to push the section in the direction of arrow C in Figure 7 in a feed direction towards a pin inserting machine shown in Figure 9.

Referring to Figure 9, the rail 34 of the feeding apparatus shown in Figures 6 to 8 is shown abutting the pin inserting machine shown in Figure 9, so that when the section is fed by activation of the cylinder 62, the section is pushed into indexing mechanism 66 of Figure 9. Figure 9 shows a lattice section 12 which has been partly processed by the machine of Figure 9 (ie. which is almost passed all the way through the machine of Figure 9). When the section 12 is initially fed into the machine of Figure 9 from the loading apparatus from Figures 6 to 8, end 12b of the section 12 is pushed into the indexing mechanism 66 which is able to grip the section 12 and index the section 12 through the machine of Figure 9.

The indexing mechanism 66 is shown in more detail in Figure 10 and is supported on frame 67 of the machine, which may include legs 68 and cross members 69.

The indexing mechanism 66 comprises a positioning cylinder 70 which may be a pneumatic or hydraulic cylinder, or in other embodiments, a linear bearing or other translating mechanism. In the preferred embodiment, the cylinder 70 has a ram arm 72 which can extend from or be retracted back into the cylinder 70. The ram arm 72 carries a bracket 74 at its free end and a clamp housing 76 is coupled to the underside of the bracket 74. The clamp housing 76 is generally a rectangular box which has an entry opening 77 on one side, and an exit opening 78 on the other side, through which the section 12 can pass. The bracket 74 also mounts a clamping cylinder 79 which has a ram arm 80 which projects into housing 76 and which carries an abutment plate 82. When the section 12 has

been pushed into the mechanism shown in Figure 10 by the feed cylinder 62, the section 12 will pass through the housing 78. By actuating the cylinder 79, the ram arm 80 will extend to push the plate 82 towards the section 14, so the section 12 is clamped between the plate 82 and lower surface 83 of the housing 76. The positioning cylinder 70 is fixed to the frame 67 by a fixing plate 85 so that when the ram arm 72 is extended, the clamp housing 78, and therefore the section 12, is indexed in the direction of arrow D in Figure 10 by a distance equivalent to the stroke of the ram arm 72. After the section 12 has been indexed by that distance, the cylinder 79 is again actuated to retract the arm 80 so that the plate 78 is moved away from the section 12 to thereby release the section 12, and the arm 72 is retracted so that the housing 78 can slide relative to the section 12 whilst leaving the section 12 in the advanced position to which it has been moved by the extension of the ram arm 72. A pin insertion operation can then be performed on the section 12, as will be described in detail hereinafter, and after that operation has been performed, the cylinder 79 is again actuated so as to clamp the section 14 in the manner described above, and the arm 72 is again extended so that the section 12 is indexed a further distance equivalent to the stroke of the arm 72. A further pin insertion operation can take place, and this sequence of indexing the section 12 continues until the section 12 has passed completely through the apparatus shown in Figure 9.

As shown in Figure 9, a pin press assembly 90 is provided for inserting the pins 20 into the section 12, as the section 12 is indexed through the apparatus of Figure 9. As shown in Figure 11, the mechanism 90 basically comprises a frame assembly 92 which supports a press cylinder 94. The press cylinder 94 has a ram arm 96 which has a pin head 98 at its free end which has a cavity or socket designed to receive and hold the pin 20 for

pressing the pin 20 into the section 12, as will be described in more detail hereinafter.

The pins 20 are supplied from a rotary pin drum 100 which is mounted on an axle 101 for rotation about the axle 101. A drive motor 102 is mounted in the frame 67 and a belt 103 extends from the drive motor 102 and about the drum 100 for rotating the drum 100 on the axle 101.

Figures 12 and 13 show more detail of the drum 100. As is apparent from Figure 13, the drum 100 is supported on the axle 101, which is in turn supported by a post 102 connected to the frame 67. A feed chute 104 extends into the drum 100 and is inclined from an uppermost end 105 which is located in the drum 100, to a lower end 106 which is arranged adjacent a feed plate 107, which is mounted on a spindle 108. The chute 104 is a box section which has an elongate slot extending along its length, and projects into the drum 100 through an opening 106 in the drum 100 which is large enough to accommodate rotation of the drum 100 relative to the chute 104. The drum 100, as is best shown in Figure 12, has a plurality of pick-up paddles 109 which extend radially inward from the outer periphery of the drum 100 and which circulate a large number of pins 20 within the drums so that the pins 20 are carried up on the paddles 109 and then drop under the influence of gravity from an upper portion of the drum 109 down on to the chute 104. Randomly, pins 20 will land on the chute 104 in an orientation where they can fit into the elongate groove in the chute 104 in a generally upright position with the mid-section 22 of the pins resting on the upper surface of the chute 104, and one of the pin sections 28 or 30 extending into the groove and the other of the pin sections 28 or 30 projecting away from the chute 100, as shown in Figure 13. Obviously, the pin sections 28 and 30 are a mirror image of one another and therefore, it does not matter which extends outwardly of the chute 104

because both are identical. The pins 20 are therefore able to slide down the inclined chute 100 towards the feed plate 107.

As is shown in Figure 14, the feed plate 107 has a plurality of cut-outs 110 about its periphery and the feed plate 107 is rotatable with the spindle 108 so that as the spindle 108 and feed plate 107 index, the recesses 110 will in turn present at the end 106 of the chute 104 and allow one of the pins to slide off the end 106 of the chute 104 and into the recess 110 with the mid-section 22 of the pin 20 resting on the upper surface of the plate 107, and one of the pin sections 28 or 30 projecting down through the recess or cut-out 110.

As is apparent from Figure 15, the press cylinder 94 is arranged so that the head 98 is at the periphery of the plate 107, as is best shown in the end view of Figure 15. As is also clearly seen in Figure 15, the section 14 is supported on a guide rail or slide surface 51 and can move on the surface 51 beneath the feed plate 107.

The spindle 108 has an indexing plate 111 connected to its end opposite the feed plate 107. As is best shown in Figure 18, the indexing plate 111 includes a plurality of ratchets 112 which basically are arranged around the plate 111, coincident with the notches or cut-outs 110 in the feed plate 107. An indexing cylinder 113 is pivotally mounted to frame 67 and has a ram arm 114 which carries a roller 115 at its end. The roller 115 engages in one of the ratchets 112 and when the ram arm 114 is extended, the ratchet plate 112 is rotated in the direction of arrow E in Figure 18 to index the plate 111 1/6 of a revolution (in the preferred embodiment) which corresponds to the spacing of the cut-outs 110 in the plate 107. As the cylinder 113 indexes the plate, the cylinder 113 can pivot on pivot pin 113a which pivotally mounts the cylinder 113

on a block or bracket 67a of the frame 67. Thus, the cylinder 113 can move between the position shown in solid lines in Figure 18. The positions in dotted lines are marked 113' in Figure 18 as the ram arm 114 is extended to index the plate 111 and then returns to engage in the next notch 112 for the next indexing movement of the plate 111. Rotation of the indexing plate 111 also rotates the spindle 108 which in turn rotates the feed plate 107 so that one of the notches 110 is moved from a position immediately below the head 98 of the press assembly to bring the next notch 110 into a position below the head 98, which defines an insertion station for the insertion of pins 20 in the section 14. The indexing of the feed plate 107 also presents the next notch 110 at the end 106 of the chute 104 so another pin can load into an empty notch 110 so as to be carried by the plate 107 to the insertion station as the plate 107 is indexed in the manner described above. After the plate 111 and plate 107 has been indexed, the ram arm 114 is retracted so as to engage in the next ratchet cut-out 112. A spring 115a is provided for biasing the cylinder 113, and therefore the roller 115, so that it remains in contact with the periphery of the ratchet plate 111 so that the roller 115 will locate in the next ratchet 112 when the ram arm 114 is retracted. Thus, by sequential extension and retraction of the ram arm 114, the indexing plate 111, and therefore the feed plate 107, is indexed in rotary fashion so as to sequentially bring each of the notches 110, and therefore a pin 20 (not shown in Figure 14) to the insertion station immediately below the head 98 of the press cylinder 94.

As is shown in Figure 15, the ram arm 96 of the press cylinder 94 has a bracket 116 connected to it, to which is attached a downwardly extending lever arm 117. The lever arm 117 carries a wedge 118 which has an inclined wedge surface 119. As is apparent from Figure 15 and Figure 16,

as the lever arm 117 moves down with the ram arm 96, a pin can be engaged by the head 98 and further downward movement of the ram 96 and arm 117 will cause the wedge surface 119 to push arm 210 to the left in Figure 15 and Figure 16. The arm 210 is connected to a swing arm 211 which is pivotally mounted to frame 67 on a pivot pin 212. The arm 211 also carries a bracket 213 to which is pivotally connected ram arm 214 of a cylinder 215. The cylinder 215 is connected at its opposite end to a bracket 67b of the frame 67 and a pivot pin 216. The spindle 108 is supported by the swing arm 211 so that when the arm 210 moves to the left and the swing arm 211 is rotated about the pin 212, the spindle 108, and therefore also the indexing plate 111 and the feed plate 107, is swung also towards the left so that the feed plate 107 is moved out of the path of the advancing ram arm 96 and the pin which is carried by the head 98. Thus, the pin can be applied to the lattice section 12 without interference from the feed plate 107. When the ram arm 96 is retracted, cylinder 215 is actuated to push the swing arm 211 back to its starting position so that the arm 210 again engages the wedge surface 119 of the wedge 118. The arm 210 may carry a roller 215 to facilitate relative movement between the surface 119 and the arm 210.

When the ram arm 96 is extended, the head 98 moves downwardly and engages the pin 20, located in the notch or cut-out 110. The plate 107 is then swung out of engagement with the pin 20 which is held in the head 98, so that the feed plate 107 is out of alignment with the pin 20 and the ram arm 96. Continued downward movement of the ram arm 96 will push the pin into the wall 12a of the section 14 so the pin bursts through the wall 12a, as described previously, and with the serrated part 38 of the pin section gripping in the wall 12a so as to securely fasten the pin 20 in the section 12. Each time the section 12 is indexed through the machine via the indexing

cylinder 70 in the manner previously described, the feed plate 107 is also indexed, so that when the section 12 stops, a new pin 20 is pressed into the section 14 by the cylinder 94 and arm 96. Thus, by sequentially indexing the section 12 through the apparatus of Figure 9 and inserting pins along the length of the section 12, a lattice section is provided with a plurality of embedded pins securely fixed to the section 12 by their first pin portions 28, and with shoulder 24 resting on the outer surface of wall 12a, and with the second pin portion 30 projecting outwardly from the section 12.

As the section 12 is indexed through the apparatus of Figure 9, the section passes onto an unloading rack 120, which is shown in Figures 19 to 23. The rack 120 includes support legs 121 and 122 and inclined support platform 128, which is formed by a plurality of inclined members which extend between the legs 121 and 122.

At the upper end of the inclined platform 128, a generally angle iron support 130 is provided onto which the sections 14 slide after they exit the apparatus of Figure 9. A stop 132 is provided at the lower end of the inclined platform 128, and as best shown in Figure 23, may simply comprise a box section rail 132 which extends slightly up above the lowermost end of the inclined platform 128.

As shown in Figure 21, the rail 130 is provided with an air ejection nozzle 135 and the rail 130 is just wide enough to just accommodate the width of the section 12, as is best shown in Figure 22. A source of compressed air (not shown) is connected to the air ejection nozzle 135 and is controlled by a valve (not shown) so that when the section 12 has been loaded onto the bracket 130, a blast of air can be ejected from the nozzle 135 to blow the lattice section 12 sideways onto the inclined platform 128 so that the section 12 slides down the inclined platform

128 and abuts the rail 132, as shown in Figure 23. As each section 12 is processed by the apparatus of Figure 9 to provide the pins 20, the sections 12 are delivered onto the apparatus of Figure 20 and then slide onto the inclined platform 128, so that the sections 12 can easily be collected by a workman and move to a storage location, or simply passed onto the next section of the apparatus for immediate processing.

The sections 12 are next cut by a cropping guillotine shown in Figures 24 and 25 to a predetermined length to suit the size of a lattice which is required. The cutting guillotine comprises a platform 140 which is supported on legs 142. A guillotine blade 144 is connected to a press cylinder 145 by ram arm 146. The platform 140 includes a stop 149 which can be moved along the platform 140 in the direction of double-headed arrow D so as to set a prescribed distance between the stop 149 and the shear blade 144, to thereby enable the sections 14 to be cut to a prescribed length which is defined by positioning of the stop 149. The sections 12 (not shown in Figures 24 and 25) are slid along guide rail 147 supported on the platform 140 until the end of the section 14 abuts the stop 149. The cylinder 145 is then activated to move the shear blade 144 down to cut the section 12 to the prescribed length.

It should be noted that sections 14 which are not provided with pins 20 can also be cut to a desired length in the cropping guillotine of Figures 24 and 25.

In order to complete assembly of the lattice, the lattice sections 12 are positioned on a transfer table 160, with the pins 20 projecting upwardly from wall 12a of the sections 12 which are uppermost when the sections 12 are positioned on the table 160.

Sections 14 are then arranged on the sections 12 in overlapping configuration so as to form the configuration of the required lattice (ie. either the configuration shown in Figure 1 or the configuration shown in Figure 2). The sections 12 and 14 are assembled on the table 160 in the folded position with the sections 14 abutting one another, and the sections 12 also abutting one another and being arranged perpendicular to the sections 14 in one or other of the patterns shown in Figures 1 and 2. In another embodiment, different configurations or angling of the overlapping sections 12 and 14 could also be used if desired.

The apparatus of Figures 26 to 28 include a roller assembly 170 which includes four pairs of rollers 172, 174, 176 and 178. The rollers 172 to 178 are supported in a roller frame 180. The lowermost rollers 172' to 178' are provided with a pulley or sprocket 171 at their free end and a continuous belt 179 extends about those sprockets. A motor 181 drives an endless belt 182, which in turn extends around a sprocket 173 on the lowermost roller 178'. Thus, the roller 178' is driven by the motor 181 and the endless belt 179 drives the other rollers 172' to 176'. The upper rollers in outer roller pair 172 to 176 are idler rollers and rotate when the lattice assembly is pulled through the roller assembly 170.

The two rollers in each of the roller pairs 172 are separated by a distance which gradually decreases from entry roller pair 172 to exit roller pair 178. Most preferably, the distance between the rollers in each pair 172 to 178 decreases by an amount of 1mm from the preceding pair of rollers.

The bottom roller in each roller pair 172 to 178 are fixed and do not move. The top roller in each roller pair 172 to 178 is mounted in a support structure which comprises a

pair of brackets 191 and 192 which can slide in the framework 180. A screw threaded shaft 193 passes through top plate 194 and nut 195 supported in the top plate so that when the shaft 193 is rotated, the brackets 191 and 192 can slide upward and downwardly in the frame 180 to position the upper roller in each pair relative to the bottom roller to thereby space the rollers apart by the prescribed distance.

The transfer table 160 and the run off table 190 may include idler rollers 197 which facilitate movement of the assembled lattice into the roller assembly and exit of the lattice from the roller assembly.

Although the preferred embodiment of the invention utilises cylinders which are most preferably pneumatic cylinders, the cylinders could be replaced by other translation devices such as linear bearings, or the like. The hydraulic cylinders are controlled by a program logic controller (not shown) which sequence actuation of each of the cylinders so that the bottommost lattice section 12 stacked on the apparatus of Figure 6 is first moved for feeding by the feed cylinder 62. The feed cylinder 62 is then actuated to push the lattice section 12 into the indexing mechanism 66. The cylinders 60 and 62 are then retracted ready for their next operation to move the next lattice section into position. The sequence of operation in the machine of Figure 9 is to first operate the cylinder 79 to clamp the lattice section 12 and then operate the cylinder 70 to index the lattice section 12. The clamp 79 is then released by withdrawing the ram arm 80 and the ram arm 72 is retracted by the cylinder 70. Whilst the retraction of these cylinders takes place, the cylinder 94 can be actuated to press a first pin 20 into the lattice section 12. As the lattice section 12 is being indexed forward by the cylinder 70, the feed plate 107 is being returned to its indexing position for

collecting a pin from the chute 104 and is being indexed by the index plate 111 and cylinder 113 to bring a new pin 20 to the insertion station beneath the ram arm 96. After the section 12 has been indexed, the feed plate 107 is moved out of the way after the ram arm 96 engages the pin 20 and then continued movement of the ram arm 96 presses the next pin into the slat 12.

The assembled lattice is fed into the nip between the roller pair 172, and the roller pair 172 therefore draws the lattice between the rollers 172 which presses the section 14 towards the section 12 so that the second pin section 30 of the pin 20 begins to burst through the wall 14a of the section 14. As the assembled lattice sections 12 and 14 continue to pass through the roller assembly 170, the section 14 is pushed further towards the section 12 by the ever-decreasing space between the pairs of rollers in each pair 174 to 178 in 1mm increments so the section 14 is incrementally pushed towards the section 12 so the pin section 30 continues to burst through the wall 14a so that the pin section 30 is fully embedded in the section 14 with the serrated section 38 gripping the wall 14a and with the outer surface of the wall 14a resting on the shoulder 26 of the mid-section 22. Thus, a complete lattice is formed by one pass through the roller assembly 170, and since the pin section 30 bursts through the wall 14a in the same manner as the pin section 28 bursts through the wall 12a, the connection of the section 14 to the pin 20 is extremely sturdy whilst still allowing pivotal movement of the section 12 on the pin 20 relative to the section 14.

After the lattice has completely passed through the roller assembly 170, the lattice moves onto a run-off table 190 and then can be manually lifted off the table 190. In order to move the lattice into its open or deployed position, the lattice is simply pulled so that the

sections 12 and 14 pivot relative to one another on the pins 20 and move into the open position shown in Figure 1 or Figure 2, depending on the configuration of the lattice.

Figure 29 is a view of a jig 250 located on transfer table 160, and Figure 30 is a cross-sectional view through the jig 250 and the table 160. The jig supports the assembled lattice in the manner described above and the jig with the assembled lattice is fed through the roller assembly 170 to assemble the lattice in the manner previously described.

As shown in Figures 29 and 30, the jig 250 comprises a bottom platen 251 which rests on the transfer table 160. The platen 251 has a plurality of upstanding locater pins 252. As is apparent from Figure 29, the locater pins 252 are formed in a grid like pattern and define multiple intersecting channels 280 in which lattice sections 12 and 14 can be located.

The platen 251 and the pins 252 shown in Figure 29 are arranged to form a lattice of the type shown in Figure 2, in which the lattice sections are arranged at 45 degrees to be vertical and horizontal. As is apparent from Figure 29, the lattice sections 12 are laid on the platen 251 between various sets of the pins 252, ie., arranged diagonal to the vertical and horizontal in Figure 29. The pins 20 of the lattice sections 12 extend upwardly from the lattice sections 12. The lattice sections 14 are then arranged on the lattice sections 12 and the pins 20. As is apparent from Figure 29, the lattice sections 12 and 14 when in the assembled condition on the jig, are in a almost fully closed configuration. This obviously facilitates a formation of a relatively larger lattice when opened into the open condition but occupies smaller space for movement of the assembled lattice sections

through the roller assembly 170.

A top platen 260 is provided (which is shown in Figure 30 but not in Figure 29) and which is a plurality of holes or bores 261 which register with the pins 252. The platen 260 is located over the pins 252 and rests on the lattice sections 14. The bores 261 may extend all of the way through the platen 260 or only part way through as shown in Figure 30. The thickness of the platen 260 is such that when the platen 260 is fully pressed down towards the platen 251, the locater pins 252 are accommodated in the bores 261 but do not extend all the way through to the opposite side of the platen 260 so they do not interfere with the pressing operation when the assembled jig 250 and the lattice sections 12 and 14 are rolled through the roller assembly 170. Thus, the assembled jig 250 can be moved off the transfer table 160 and into the nip of the roller assembly 170 and as the jig passes through the roller assembly 170, the top platen 260 is pushed downwardly towards the bottom platen 251 to, in turn, push the sections 14 downwardly so that the pins 20 penetrate sections 14 to assemble the lattice.

After the jig 250 has moved fully through the roller assembly 170, the top platen 260 is removed and the assembled lattice can be lifted away from the locater pins 252. In order to place the assembled lattice in an orientation for use, the lattice section is simply pulled apart at the end so that the sections 12 and 14 pivot on the pins 12 into the open condition shown in Figure 2.

It should be noted that the lower platen 251 in Figure 29, could also be used to form the 90 degree lattice shown in Figure 1, but the configuration of the pins 252 would mean that the lattice would basically be formed in the open condition shown in Figure 1. If it is desired to form the 90 degree lattice in a closed or collapsed position, a

different pin configuration to that shown in Figure 29 is required for the lower platen 251.

Figure 31 shows a preferred modification to the jig shown in Figure 30 to facilitate removal of the formed lattice from the lattice pins 252 after the jig 160 has passed through the roller assembly. In Figure 31, the jig 160 is provided with an ejector plate 270 which includes a plurality of holes 272 through which the pins 252 pass. The lattice sections 12 and 14 are located in the same manner as previously described. Arranged between the ejector plate 270 and the platen 251 are two square tubes 271 (only one shown) which extend along the sides of the jig at opposed edges of the ejector plate 270. The tubes 271 are connected to a compressed air supply conduit 275 which has a hand operated valve 276, and the conduit 275 is connected to a source of compressed air 277. The tubes 271 are provided with holes 273 in a vertical side edge so that the holes direct and generally face towards one another and into the space which is formed between the ejector plate. The ejector plate 270 has skirts 279 at its other two sides which generally run between the tubes 273 so that when air enters the cavity between the base 251 and the plate 270, the air pressure forces the plate 270, together with the lattice sections 12 and 14, upwardly relative to the pins 252.

Thus, after the lattice has been pressed by the roller assembly and the top platen 260 (not shown in Figure 31) removed, the valve 276 is opened to supply compressed air to the tube 271. The air exits the holes 273 and pushes the ejector plate 270 upwardly relative to the bottom platen 251 and the pins 252 to thereby lift the lattice sections 12 and 14, and therefore the formed lattice, from the pins 252.

Since modifications within the spirit and scope of the

invention may readily be effected by persons skilled within the art, it is to be understood that this invention is not limited to the particular embodiment described by way of example hereinabove.